Report for 2003KY24B: Evaluation of ground water sustainability in the Ohio River alluvial aquifer near Westport, Oldham County, Kentucky

- Conference Proceedings:
  - Boateng, Samuel, 2004, Evaluation of ground water sustainability in the Ohio River Alluvial Aquifer near Westport, Oldham County, Kentucky, in Proceedings of the Kentucky Water Resources Annual Symposium, Kentucky Water Resources Research Institute, Lexington, Kentucky, 11-12.
  - Boateng, Samuel, and Matt Suedkanmp, 2004, Managing ground water resources to meet future water supply demands in a rural setting in northwestern Kentucky, in GSA Abstracts with Programs, Geological Society of America, 36(3).

Report Follows

Problem and Research Objectives

Ground water is an important source of drinking water in some regions of the State of Kentucky, including Oldham County where alluvium and glacial deposits along the Ohio River valley are the main source of ground water. The aquifer in this area is made up of sand and gravel. Generally, the aquifer can produce water to supply 50 to 250 homes per well (Carey and Stickney, 2001). There is a projected increase in population to about 53,000 residents in the county by the year 2020. Cities such as La Grange, Westport, and Buckner are growing rapidly. Future development of new subdivisions for single and multi-family homes is becoming almost inevitable. Some of these subdivisions may be developed in areas that contribute water to the existing ground water production wells of the Oldham County Water Division. The increase in population means more demand for water. The associated increase in human activities that generate contaminants may also pose serious problems to the quality of the drinking water source.

Objectives of this study include answering the following questions:

1. Can ground water supply in Oldham County be augmented by installing additional high-yield wells near Westport, Kentucky?
2. Would these new wells have any adverse impacts on the total aquifer drawdown?
3. What would be the potential impact of expansion of residential development be on the quality of ground water?

Objective question (1) is slightly different from the original proposal. After consulting the Oldham County Water Division, it became clear that the existing wells already are pumping at their maximum design capacity.

Methodology

Flow simulations and particle tracking were used to answer the objective questions. Flow simulations were performed by using the computer program MODFLOW and the subsequent particle tracking was completed with the MODPATH computer program. The simulated area encompassed all of the existing Oldham County Water Division production wells near Westport, Kentucky. This area has a transverse width that ranges from 600 m to1,800 m, and a longitudinal dimension of about 4,900m. From well log data and studies in the vicinity of the area, a mean hydraulic conductivity value of about 90 m/day was used (ranges between 30 to 180 m/day). Two conceptual flow models were proposed: a one-layer unconfined model and a two-layer semi-confined/confined model. In both cases, the western boundary was modeled as a river and the eastern boundary was a general head boundary. The models were calibrated by using water levels measured in observation wells. After the calibration, the total drawdown of the aquifer was noted pumping all five of the current production wells at their maximum capacities. The pumping rates range from 830 m^3/day to 4870 m^3/day. The capture zones were also determined.

The effect of potential future increases in production rate was simulated by including three wells to the north of the existing well field with each new well pumping

at a rate of 4,200 m^3/day. The maximum drawdown within the aquifer was noted for different scenarios representing normal, drought, and high (flood) Ohio River flow conditions. Again, the capture zones were determined.

This methodology is slightly different from the original proposal because of the change in objective question 1. Thus, the evaluation of flow by progressive increase in pumping rates was not practical. Also, a distribution of septic systems was not used to evaluate the potential for contamination as proposed. The capture zone areas combined with the thickness of the overlying silt and clay were used to evaluate the potential for septic system contamination.

Principal Findings and Significance

1. From the calibration data, the semi-confined/confined simulation represented the flow regime better.
2. Maximum drawdown occurring when all of the wells (including potential future wells) are pumping in a drought condition is about 7 m. The aquifer has a thickness of 22 m and this may not have a significant effect on the aquifer yield and could sustain the potential increase in water demand.
3. Aquifer is less vulnerable to contamination along the Ohio River but may be vulnerable in the capture zone areas where silt and clay cover is thin.
4. The capture zones cover about a third of the study area (mainly in the north central part) and any residential development within this zone may pose a potential threat to ground water quality. About half of this area has very thin silt and clay overlying the aquifer, although the water level is about 12 m below the ground surface. At high river stage (flooding scenario), the water level is within about 3 m of the ground surface.